CLAIMS

What is claimed is:

1. A method for preparation of a solid state electrochemical device having a cathode, an anode and an electrolyte positioned between the cathode and the anode, comprising in combination, the steps of:

forming a controlled geometry feedrod having a cross sectional area, comprising at least a first extrusion compound and a second extrusion compound; and

co-extruding the controlled geometry feedrod through a reduction die at least once to create a co-extruded article having a desired reduction in the cross sectional area.

2. The method according to claim 1 wherein the first extrusion compound comprises one of a first ceramic and a metal powder filled thermoplastic, and the second extrusion compound comprises one of a second ceramic and a second metal powder filled thermoplastic.

3. The method according to claim 1 wherein the electrolyte is formed as part of the controlled geometry feedrod and the cathode and the anode are formed in subsequent steps.

4. The method according to claim 1 wherein the electrolyte and one of the cathode and the anode are formed as part of the controlled geometry feedrod and the other of the cathode and the anode is formed in a subsequent step.

5. The method according to claim 1 further comprising adding at least one ancillary material to the controlled geometry feedrod.

6. The method of according to claim 5 wherein the ancillary material comprises at least one of:

a rigidity enhancing material;

a current collector;

an electrical interconnection material to enhance electrical communication of the solid state electrochemical device; and

a reforming catalyst.

7. The method according to claim 1 further comprising the step of matching rheological behavior of the first and second extrusion compounds with a high shear mixer.

8. The method according to claim 1 further comprising heating the die as the feedrod is reduced.

9. The method according to claim 1 further comprising sintering the co-extruded article after the controlled geometry feedrod has passed through the reduction die.

10. The method according to claim 1 wherein the first extrusion compound and the second extrusion compound comprise an extrudable thermoplastic carrier material.

11. The method according to claim 1 wherein the anode comprises a material with nickel.

12. The method according to claim 1 wherein the anode comprises a first material forming an electrochemically active area, and a second material forming a current collector.

13. The method according to claim 1 wherein the cathode comprises a conductive material stable under oxidizing conditions.

14. The method according to claim 1 further comprising the steps of:

co-extruding a fugitive material as part of the controlled geometry feedrod; and

forming at least one projection in the co-extruded article by removing the fugitive material.

15. The method according to claim 1 wherein the electrolyte comprises an oxygen ion conducting oxide.

16. The method of claim 1 wherein the first compound and the second compound comprise a thermoplastic polymer binder, and the co-extruded article is heated to remove the polymer binder and form at least the electrolyte.

17. The method of claim 1 further comprising the steps of:

co-extruding a fugitive material as part of the controlled geometry feedrod; and

forming a series of passageways in the co-extruded article by removing the fugitive material with heat.

18. The method of claim 1 further comprising the step forming the anode with at least first and second distinct regions having at least one of a different pore volume, size, shape, connectivity, catalyst materials, and electrical conductors.

19. The method of claim 1 further comprising the step forming the cathode with at least first and second distinct regions having at least one of a different pore volume, size, shape, connectivity, catalyst materials, and electrical conductors.

20. A method for preparation of a solid state electrochemical device having a cathode, and anode and an electrolyte positioned between the cathode and the anode, comprising in combination, the steps of:

forming a feedrod having a cross sectional area, comprising at least a first extrusion compound and a second extrusion compound, wherein the feedrod holds its shape upon forming; and

co-extruding the feedrod through a reduction die at least once to produce a co-extruded article having a desired reduction in the cross sectional area.

21. The method according to claim 20 wherein the solid state electrochemical device is formed in the shape of a tube.

22. The method according to claim 20 wherein as the cross sectional area of the feedrod decreases and the feedrod is elongated as it is co-extruded.

23. A method for preparation of a solid state electrochemical device having a cathode, and anode and an electrolyte positioned between the cathode and the anode, comprising in combination, the steps of:

forming a feedrod by:

molding a fugitive material;

molding an anode around the fugitive material;

molding an electrolyte around the anode; and

molding a cathode around the electrolyte; and

co-extruding the feedrod through a reduction die at least once to achieve a desired reduction in the cross sectional area of the feedrod, thereby producing a co-extruded article.

24. The method according to claim 23 further comprising the step of heating the feedrod to remove the fugitive, so that the co-extruded article has a tube-shaped structure.

25. The method according to claim 23 further comprising the steps of:

forming a series of feedrod sections having ends; and

forming a manifold around the ends to form a tubular bundle.

26. The method according to claim 25 further comprising the step of enveloping the tubular bundle in a gas permeable material.

27. The method according to claim 26 wherein the gas permeable material is made from one of a non-electronically conducting ceramic fiber and a non-electronically conducting open cell ceramic foam.

28. The method according to claim 23 wherein the cathode and the anode each comprise electron conducting materials and ion conducting materials.

29. A method for preparation of a solid state electrochemical device having a cathode, and anode and an electrolyte positioned between the cathode and the anode, comprising in combination, the steps of:

forming a feedrod having a cross sectional area, wherein at least one of the cathode and the anode is formed as a powder filled polymer having at least first and

second regions, with the first region comprising an active area and the second region comprising a current collector; and

co-extruding the controlled through a reduction die at least once to achieve a desired reduction in the cross sectional area of the feedrod.